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Device and method for connecting objects

The present invention relates to a device and a method for connecting objects, particularly components in the semiconductor technology, such as for connecting a wafer or substrate with a carrier or for connecting two wafers or substrates. Usually, such a connection is achieved by means of an adhesive or an adhesive film between the two objects.

In the semiconductor technology, methods are required that allow for a preferably plane-parallel connection of a wafer and a carrier without air being trapped. In the prior art, it is known to establish such a connection in a vacuum chamber or an evacuated pressing environment. The vacuum chamber or the evacuated pressing environment according to the prior art, however, has a large volume so that long evacuation times are necessary, which involve high costs and a low throughput speed of the objects.

Reference is made to the following prior art references: DE 196 10 112 C2, DE 100 48 881 A1, JP 02-123 726 A, DE 197 07 771 A1, US 5 602 058, JP 64-045567 A, US 4 316 757, EP 0 488 267 A2.

The present invention is based on the object of providing a device and a method for connecting objects, which avoid the aforementioned disadvantages of the prior art.

This object is achieved by the features of the claims.

For achieving this object, the invention is based on the following basic idea.

A strictly localised vacuum is generated between and around the objects to be connected. The expansion of the vacuum or the vacuum chamber is essentially restricted by the horizontal and vertical dimensions of the objects to be connected and the flow resistance during the air evacuation, which is due to the too small dimensions of the volume to be evacuated. The vacuum between the objects to be connected is to achieve a compression of the objects by the atmospheric pressure. The compression of the objects may additionally be controlled by a respective pressing device.

The present invention involves the following advantages.

Only short evacuation times are necessary thus enabling a high object throughput. Air occlusions between the objects are reliably avoided. Object deformations and stress in the

material are prevented, and two objects as well as groups of objects (single wafer mounting and batch wafer mounting) may be connected in one step. The device according to the present invention is applicable in standard Scara (selective compliance assembly robot arm) robots as well as in travelling axles. Conventional adhesives and adhesive films may be used for the connection. However, direct joining without the use of any adhesives is also possible, for example by adhesion between the two substrates. The device according to the present invention may be produced at low cost and is suitable for laboratories as well as fully automated systems.

In the following, the present invention will be illustrated in more detail by means of drawings, in which:

Fig. 1 shows a cross-section of an embodiment of the present invention, and

Figs. 2a-2c show steps of the method according to the present invention using the device according to Fig. 1.

According to Fig. 1, the inventive device comprises a mounting 4 to which a first object 1 (such as a substrate or waver) is fastened by means of the vacuum of a vacuum holding means 7. A protective film 11 is placed between the first object 1 and the mounting 4. Around the mounting 4, there is a vacuum chamber ring 6 which is connected to and sealed off against the mounting 4 by means of a first seal ring 9. The connection between the mounting 4 and the vacuum chamber ring 6 is preferably achieved by tension springs 14 which, if non-operated, draw or hold the two parts 4 and 6 according to Figs. 1, 2a and 2c vertically together to the stop position.

The mounting 4 and the vacuum chamber ring 6 form a lid which, if lowered (Fig. 2a), forms a vacuum chamber 3 together with a table 5. At the lower end of the vacuum chamber ring 6, which end is opposite the table 5 on which a second object 2 (such as a substrate or wafer) is placed, there is a second seal ring 10. The vacuum chamber ring 6 is provided with an opening 8 for evacuating and aerating the vacuum chamber 3. To this end, a vacuum pump P is connected to the opening 8, if necessary via an isolating valve 12; aeration is achieved via an air valve 13 while valve 12 is closed. The lower end of the vacuum chamber ring 6 protrudes over the surface of the first object by a distance that is longer than the thickness of the second object 2. Thus, as shown in Fig. 2a, a distance d is formed between the first object 1 and the second object 2 as the vacuum chamber ring 6

contacts the surface 5a of the table 5. The lowered state of the lids 4, 6 on the table 5 is shown in Fig. 2a.

Figs. 2a to 2c show steps of the method according to the invention using the device according to Fig. 1.

The mounting 4 with the vacuum chamber ring 6 and the first object 1 is situated above the second object 2 located on the table 5 (cf. Fig. 1). According to Fig. 2a, this mounting 4 is lowered onto the table 5 in the direction of the arrow A, while the second seal ring 10 rests on the table surface 5a. However, there is still a distance d between the first object 1 and the second object 2 so that the two objects may not yet get into contact. The distance d is selected sufficiently large so that the gas flow resistance between the two objects 1 and 2 is sufficiently low during the evacuation. Preferably, the distance d is approximately 1 mm to 5 mm. Fig. 2a shows the device according to the invention while the vacuum chamber 3 is formed before the evacuation.

The chamber 3 is evacuated via the opening 8. The mounting 4 is movable with respect to the first seal ring 9 of the vacuum chamber ring 6 and is moved downwards towards the table 5 in the direction of the arrow A against the tensile force of the optional tension springs 14 by the atmospheric pressure while the vacuum chamber ring 6 is static. Preferably, the elastic force of the tension springs 14 is selected such that, during the evacuation of the chamber 3, the mounting 4 is automatically pressed downwards in the direction of the arrow A (Fig. 2a) by the atmospheric pressure against the tensile force of the springs 14.

In order to guarantee that the air between the objects 1 and 2 and/or gas from an adhesive may be removed by suction as quickly and completely as possible, the mounting 4 may be moved towards the table 5 in a controlled manner and this movement may be delayed e.g. intermittently or in a controlled manner. To this end, a controlled lift drive (non shown) is preferably provided for the movement of the mounting in the direction of the arrow A; the tension springs 14 are of additional advantage here as well. During this movement of the mounting 4 in the direction of the arrow A (Figs. 2a, 2b), the first object 1 is pressed onto the second object 2 and joined with the second object 2 via the pressure of the mounting 4 by means of the adhesive or adhesive film optionally placed between the two objects. This step is shown in Fig. 2b.

Then, in Fig. 2c, the vacuum chamber 3 is aerated via the opening 8, the vacuum holding means 7 is switched off and the mounting 4 is lifted upwards in the direction of the arrow B together with the vacuum chamber ring 6. The objects 1 and 2 thus connected are transported away, and the method according to Figs. 2a to 2c is repeated with new objects to be connected.

According to the invention, the device according to Fig. 1 can be provided with a spring-supported holding-down ring 15 (for simplification only shown in Fig. 1) that is aligned with the table 5 may be provided for fixing the vacuum chamber ring 6 on the table 5. In addition to the atmospheric pressure during the evacuation of the chamber 3, the mounting 4 may be delayed in a controlled manner by means of the aforementioned lift drive (not-shown) and then pressed downwards so as to increase the contact pressure between the two objects 1, 2.

The device and the method according to the invention are preferably used in semiconductor technology and the first object 1 is preferably a semiconductor substrate (wafer) and the second object 2 a corresponding carrier or a further wafer.

By means of the device and the method according to the present invention, single objects (single wafer mounting) as well as a plurality of objects (batch wafer mounting) may simultaneously be connected.